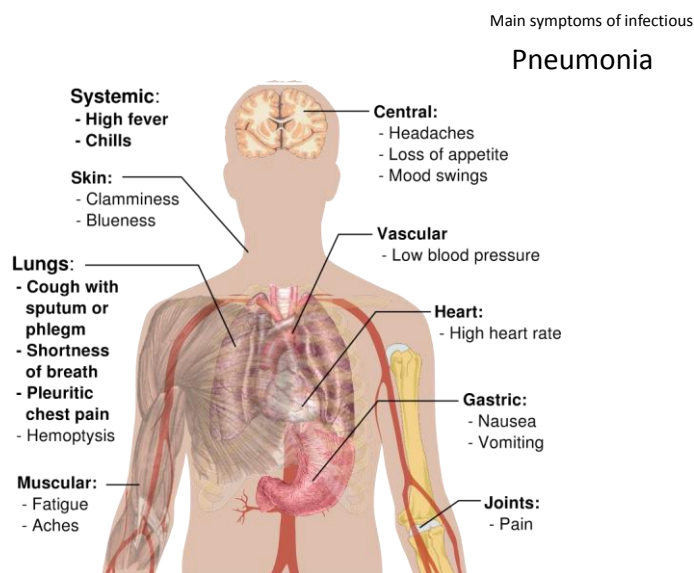


# Community-acquired pneumonia

**Community-acquired pneumonia (CAP)** refers to pneumonia (any of several lung diseases) contracted by a person with little contact with the healthcare system. The chief difference between hospital-acquired pneumonia (HAP) and CAP is that patients with HAP live in long-term care facilities or have recently visited a hospital. CAP is common, affecting people of all ages, and its symptoms occur as a result of oxygen-absorbing areas of the lung (alveoli) filling with fluid. This inhibits lung function, causing dyspnea, fever, chest pains and cough.

CAP, the most common type of pneumonia, is a leading cause of illness and death worldwide. Its causes include bacteria, viruses, fungi and parasites.<sup>[1]</sup> CAP is diagnosed by assessing symptoms, making a physical examination and on x-ray. Other tests, such as sputum examination, supplement chest x-rays. Patients with CAP sometimes require hospitalization, and it is treated primarily with antibiotics, antipyretics and cough medicine.<sup>[2]</sup> Some forms of CAP can be prevented by vaccination and by abstaining from tobacco products.<sup>[3]</sup>

## 1 Signs and symptoms 1.1 Common symptoms



- Shortness of breath (dyspnea)
- Coughing which produces greenish or yellow sputum
- A high fever, accompanied by sweating, chills and
- Sharp, stabbing chest pains
- Rapid, shallow, often-painful breathing

## 1.2 Less-common symptoms

- Coughing up blood (hemoptysis)
- Headaches, including migraines
- Loss of appetite
- Excessive fatigue
- Bluish skin (cyanosis)
- Nausea
- Vomiting
- Diarrhea
- Joint pain (arthralgia)
- Muscle aches (myalgia)
- Rapid heartbeat
- Dizziness or lightheadedness

## 1.3 In the elderly

- New or worsening confusion
- Hypothermia
- Poor coordination, leading to falls

## 1.4 In infants

- Unusual sleepiness
- Yellowing of the skin (jaundice)
- Difficulty feeding<sup>[4]</sup>

## 2 Causes

Over 100 microorganisms can cause CAP, with most cases caused by *Streptococcus pneumoniae*. Certain groups of people are more susceptible to CAP-causing pathogens; for example, infants, adults with chronic conditions (such as chronic obstructive pulmonary disease, senior citizens, alcoholics and others with compromised immune systems are more likely to develop CAP from *Haemophilus influenzae* or *Pneumocystis carinii*.<sup>[5]</sup> A definitive cause is identified in only half the cases.

### 2.1 Infants

Infants can acquire lung infections before birth by breathing infected amniotic fluid or through a blood-borne infection which crossed the placenta. Infants can also inhale contaminated fluid from the vagina at birth. The most prevalent pathogen causing CAP in newborns is *Streptococcus agalactiae*, also known as group-B streptococcus (GBS). GBS causes more than half of CAP in the first week after birth.<sup>[6]</sup> Other bacterial causes of neonatal CAP include *Listeria monocytogenes* and a variety of mycobacteria. CAP-causing viruses may also be transferred from mother to child; herpes simplex virus (the most common) is life-threatening, and adenoviridae, mumps and enterovirus can also cause pneumonia. Another cause of CAP in this group is *Chlamydia trachomatis*, acquired at birth but not causing pneumonia until two to four weeks later; it usually presents with no fever and a characteristic, staccato cough.

CAP in older infants reflects increased exposure to microorganisms, with common bacterial causes including *Streptococcus pneumoniae*, *Escherichia coli*, *Klebsiella pneumoniae*, *Moraxella catarrhalis* and *Staphylococcus aureus*. Maternally-derived syphilis is also a cause of CAP in this age group. Viruses include human respiratory syncytial virus (RSV), human metapneumovirus, adenovirus, human parainfluenza viruses, influenza and rhinovirus, and RSV is a common source of illness and hospitalization in infants.<sup>[7]</sup> CAP caused by fungi or parasites is not usually seen in otherwise-healthy infants.

### 2.2 Children

Although children older than one month tend to be at risk for the same microorganisms as adults, children under five are much less likely to have pneumonia caused by *Mycoplasma pneumoniae*, *Chlamydophila pneumoniae* or *Legionella pneumophila*. In contrast, older children and teenagers are more likely to acquire *Mycoplasma pneumoniae* and *Chlamydophila pneumoniae* than adults.<sup>[8]</sup>

## 3 PATHOPHYSIOLOGY

### 2.3 Adults

A full spectrum of microorganisms is responsible for CAP in adults, and patients with certain risk factors are more susceptible to infections of certain groups of microorganisms. Identifying people at risk for infection by these organisms aids in appropriate treatment. Many lesscommon organisms can cause CAP in adults, and are identified from specific risk factors or treatment failure for common causes.

### 2.4 Risk factors

Some patients have an underlying problem which increases their risk of infection. Some risk factors are:

- *Obstruction*: When part of the airway (**bronchus**) leading to the alveoli is obstructed, the lung cannot eliminate fluid; this can lead to pneumonia. One cause of obstruction, especially in young children, is inhalation of a foreign object such as a marble or toy. The object lodges in a small airway, and pneumonia develops in the obstructed area of the lung. Another cause of obstruction is **lung cancer**, which can block the flow of air.
- *Lung disease*: Patients with underlying lung disease are more likely to develop pneumonia. Diseases such as emphysema and habits such as **smoking** result in more-frequent and more-severe bouts of pneumonia. In children, recurrent pneumonia may indicate **cystic fibrosis** or **pulmonary sequestration**.
- *Immune problems*: **Immune-deficient** patients, such as those with **HIV/AIDS**, are more likely to develop pneumonia. Other immune problems range from severe childhood immune deficiencies, such as **Wiskott–Aldrich syndrome**, to the less-severe **common variable immunodeficiency**.<sup>[9]</sup>

### 3 Pathophysiology

CAP's symptoms are the result of lung infection by **microorganisms** and the **immune system's** response to the infection. Mechanisms of infection are different for **viruses** and other microorganisms.

#### 3.1 Viruses

Viruses cause 20 percent of CAP cases. The most common viruses are influenza, parainfluenza, human respiratory syncytial virus, human metapneumovirus and adenovirus. Less-common viruses which may cause serious illness include **chickenpox**, **SARS**, **avian flu** and **hantavirus**.<sup>[10]</sup>

Typically, a virus enters the lungs through the inhalation of water droplets and invades the cells lining the airways and the alveoli. This leads to cell death; the cells are killed by the virus or they **self-destruct**. Further lung damage occurs when the immune system responds to the infection. **White blood cells**, particularly **lymphocytes**, activate chemicals known as **cytokines** which cause fluid to leak into the alveoli. The combination of cell destruction and fluid-filled alveoli interrupts the transportation of oxygen into the bloodstream. In addition to their effects on the lungs, many viruses affect other **organs**. Viral infections weaken the immune system, making the body more susceptible to bacterial infection (including bacterial pneumonia).

#### 3.2 Bacteria and fungi

Although most cases of bacterial pneumonia are caused by *Streptococcus pneumoniae*, infections by **atypical bacteria** such as *Mycoplasma pneumoniae*, *Chlamydomphila pneumoniae*, and *Legionella pneumophila* can also cause CAP. Enteric **gram-negative bacteria**, such as *Escherichia coli* and *Klebsiella pneumoniae*, are a group of bacteria that typically live in the **large intestine**; contamination of food and water by these bacteria can result in outbreaks of pneumonia. *Pseudomonas aeruginosa*, an uncommon cause of CAP, is a difficult bacteria to treat.

Bacteria and fungi typically enter the lungs through the inhalation of water droplets, although they can reach the lung through the bloodstream if an infection is present and often live in the **respiratory tract**. In the alveoli, bacteria and fungi travel into the spaces between cells and adjacent alveoli through connecting pores. The immune system responds by releasing **neutrophil granulocytes**, white blood cells responsible for attacking microorganisms, into the lungs. The neutrophils **engulf** and kill the microorganisms, releasing cytokines which activate the entire immune system. This response causes fever, chills and fatigue, common symptoms of CAP. The neutrophils, bacteria and fluids leaked from surrounding blood vessels fill the alveoli, impairing oxygen transport. Bacteria may travel from the lung to the bloodstream, causing **septic shock** (very low blood pressure which damages the **brain**, **kidney**, and **heart**).

### 3.3 Parasites

A variety of parasites can affect the lungs, generally entering the body through the skin or by being swallowed. They then travel to the lungs through the blood, where the combination of cell destruction and immune response disrupts oxygen transport.

## 4 Diagnosis

Patients with symptoms of CAP require evaluation. Physical examination by a health provider may reveal fever, an increased respiratory rate (tachypnea), low blood pressure (hypotension), a fast heart rate (tachycardia) and changes in the amount of oxygen in the blood. Palpating the chest as it expands and tapping the chest wall (percussion) to identify dull, non-resonant areas can identify stiffness and fluid, signs of CAP.

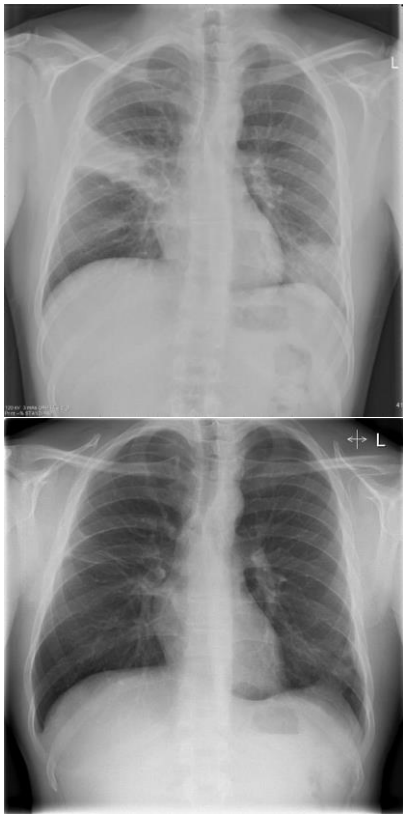
Listening to the lungs with a stethoscope (auscultation) can also reveal signs associated with CAP. A lack of normal breath sounds or the presence of crackles can indicate fluid consolidation. Increased vibration of the chest when speaking, known as tactile fremitus, and increased volume of whispered speech during auscultation can also indicate fluid.<sup>[11]</sup>

When signs are discovered, chest X-rays, examination of the blood and sputum for infectious microorganisms and blood tests are commonly used to diagnose CAP. Diagnostic tools depend on the severity of illness, local practices and concern about complications of the infection. All patients with CAP should have their blood oxygen monitored with pulse oximetry. In some cases, arterial blood gas analysis may be required to determine the amount of oxygen in the blood. A complete blood count (CBC) may reveal extra white blood cells, indicating infection.

Chest X-rays and X-ray computed tomography (CT) can reveal areas of opacity (seen as white), indicating consolidation. CAP does not always appear on x-rays, because the disease is in its initial stages or involves a part of the lung an x-ray does not see well. In some cases, chest CT can reveal pneumonia not seen on x-rays. X-rays can often mislead, as Heart failure or other types of lung damage can mimic CAP on x-rays.<sup>[12]</sup>

Several tests can identify the cause of CAP. Blood cultures can isolate bacteria or fungi in the bloodstream. Sputum Gram staining and culture can also reveal the causative microorganism. In severe cases, bronchoscopy can collect fluid for culture. Special tests can be performed if an uncommon microorganism is suspected, such as urinalysis for Legionella antigen in Legionnaires' disease.

## 5 Treatment



Chest X-rays of a CAP patient before (*left*) and after treatment

CAP is treated with an antibiotic that kills the offending microorganism and by managing complications. If the causative microorganism is unidentified (often the case), the laboratory identifies the most-effective antibiotic; this may take several days.

Health professionals consider a person’s risk factors for various organisms when choosing an initial antibiotic. Additional consideration is given to the treatment setting; most patients are cured by oral medication, while others must be hospitalized for **intravenous therapy** or **intensive care**.

Therapy for older children and adults generally includes treatment for atypical bacteria: typically a **macrolide** antibiotic (such as **azithromycin** or **clarithromycin**) or a **quinolone**, such as **levofloxacin**. **Doxycycline** is the antibiotic of choice in the UK for atypical bacteria, due to increased **clostridium difficile colitis** in hospital patients linked to the increased use of **clarithromycin**.

### 5.1 Newborns

Most newborn infants with CAP are hospitalized, receiving IV **ampicillin** and **gentamicin** for at least ten days to treat the common causative agents *streptococcus agalactiae*, *listeria monocytogenes* and *escherichia coli*. To treat

5 TREATMENT

the **herpes simplex virus**, IV **aciclovir** is administered for 21 days.

### 5.2 Children

Treatment of CAP in children depends on the child’s age and the severity of illness. Children under five are not usually treated for atypical bacteria. If hospitalization is not required, a seven-day course of **amoxicillin** is often

prescribed. With the increase in drug-resistant *Streptococcus pneumoniae*, antibiotics such as cefpodoxime may become more popular.<sup>[13]</sup> Hospitalized children receive intravenous ampicillin, ceftriaxone or cefotaxime, and a recent study found that a three-day course of antibiotics seems sufficient for most mild-to-moderate CAP in children.<sup>[14]</sup>

### 5.3 Adults

In 2001 the American Thoracic Society, drawing on the work of the British and Canadian Thoracic Societies, established guidelines for the management of adult CAP dividing patients into four categories based on common organisms.<sup>[15]</sup>

- Healthy outpatients without risk factors: This group (the largest) is composed of otherwise-healthy patients without risk factors for DRSP, enteric gramnegative bacteria, *pseudomonas* or other, lesscommon, causes of CAP. Primary microorganisms are viruses, atypical bacteria, penicillin-sensitive *streptococcus pneumoniae* and *haemophilus influenzae*. Recommended drugs are macrolide antibiotics, such as azithromycin or clarithromycin, for seven<sup>[16]</sup> to ten days.
- Outpatients with underlying illness or risk factors: Although this group does not require hospitalization, patients have underlying health problems (such as emphysema or heart failure) or are at risk for DRSP or enteric gram-negative bacteria. They are treated with a quinolone active against *streptococcus pneumoniae* (such as levofloxacin) or a  $\beta$ -lactam antibiotic (such as cefpodoxime, cefuroxime, amoxicillin or amoxicillin/clavulanic acid) and a macrolide antibiotic, such as azithromycin or clarithromycin, for seven to ten days.<sup>[17]</sup>
- Hospitalized patients without risk for *pseudomonas*: This group requires intravenous antibiotics, with a quinolone active against *streptococcus pneumoniae* (such as levofloxacin), a  $\beta$ -lactam antibiotic (such as cefotaxime, ceftriaxone, ampicillin/sulbactam or high-dose ampicillin plus a macrolide antibiotic (such as azithromycin or clarithromycin) for seven to ten days.
- Intensive-care *aeruginosa*: These patients require antibiotics for patients at risk for *pseudomonas* getting this difficult-to-eradicate bacterium. One regimen is an intravenous antipseudomonal betalactam such as cefepime, imipenem, meropenem or piperacillin/tazobactam, plus an IV antipseudomonal fluoroquinolone such as levofloxacin. Another is an IV antipseudomonal beta-lactam such as cefepime, imipenem, meropenem or piperacillin/tazobactam, plus an aminoglycoside such as gentamicin or tobramycin, plus a macrolide (such as azithromycin) or a nonpseudomonal fluoroquinolone such as ciprofloxacin.

For mild-to-moderate CAP, shorter courses of antibiotics (3–7 days) seem to be sufficient.<sup>[14]</sup>

### 5.4 Hospitalization

Some CAP patients require intensive care, with clinical prediction rules such as the pneumonia severity index and CURB-65 guiding the decision to hospitalize.<sup>[18]</sup> Factors increasing the need for hospitalization include:

- Age greater than 65
- Underlying chronic illnesses
- Respiratory rate greater than 30 per minute
- Systolic blood pressure less than 90 mmHg
- Heart rate greater than 125 per minute

- **Temperature** below 35 or over 40 °C
- Confusion
- Evidence of infection outside the lung

Laboratory results indicating hospitalization include:

- Arterial oxygen tension less than 60 mm Hg
- **Carbon dioxide** while breathing room air over 50 mmHg or **pH** under 7.35
- **Hematocrit** under 30 percent
- **Creatinine** over 20 mg/dl or over 1.2 mg/dl or **blood urea nitrogen**
- White-blood-cell count under  $4 \times 10^9/L$  or over  $30 \times 10^9/L$
- Neutrophil count under  $1 \times 10^9/L$

X-ray findings indicating hospitalization include:

- Involvement of more than one lobe of the lung
- Presence of a cavity
- **Pleural effusion**

## 6 Prognosis

The CAP outpatient mortality rate is less than one percent, with fever typically responding to the first two days of therapy and other symptoms in the first week. However, X-rays may remain abnormal for at least a month. Hospitalized patients have an average mortality rate of 12 percent, with the rate rising to 40 percent for patients with bloodstream infections or requiring intensive care.<sup>[19]</sup> Factors increasing mortality are identical to those indicating hospitalization.

Unresponsive CAP may be due to a complication, a previously-unknown health problem, inappropriate antibiotics for the causative organism, a previously unsuspected microorganism (such as **tuberculosis**) or a condition mimicking CAP (such as **granuloma** with polyangiitis). Additional tests include **X-ray computed tomography**, **bronchoscopy** or lung biopsy.

## 7 Complications

Major complications of CAP include:

- **Sepsis**, when microorganisms enter the bloodstream and the **immune system** responds. Sepsis often occurs with **bacterial pneumonia**, with *streptococcus pneumoniae* the most-common cause. Patients with sepsis



require intensive care, with blood-pressure monitoring and support against hypotension. Sepsis can cause liver, kidney and heart damage.

- Respiratory failure: CAP patients often have **dyspnea**, which may require support. Non-invasive machines (such as **bilevel positive airway pressure**), a **tracheal tube** or a **ventilator** may be used.
- Pleural effusion and empyema: Microorganisms from the lung may trigger fluid collection in the **pleural cavity**. If the microorganisms are in the fluid, the collection is an **empyema**. If pleural fluid is present, it should be **collected with a needle** and examined. Depending on the results, complete drainage of the fluid with a **chest tube** may be necessary. If the fluid is not drained, bacteria may continue to proliferate because antibiotics do not penetrate the pleural cavity well.
- **Abscess**: A pocket of fluid and bacteria may be seen on an X-ray as a cavity in the lung. Abscesses, typical of **aspiration pneumonia**, usually contain a mixture of **anaerobic bacteria**. Although antibiotics can usually cure abscesses, sometimes they require drainage by a surgeon or **radiologist**.

## 8 Epidemiology

CAP is common worldwide, and a major cause of death in all age groups. In children, most deaths (over two million a year) occur in newborn period. According to a **World Health Organization** estimate, one in three newborn deaths are from pneumonia.<sup>[20]</sup> Mortality decreases with age until late adulthood, with the elderly at risk for CAP and its associated mortality.

More CAP cases occur during the winter than at other times of the year. CAP is more common in males than females, and more common in **black people** than Caucasians. Patients with underlying illnesses (such as **Alzheimer's disease**, **cystic fibrosis**, **COPD**, **tobacco smoking**, **alcoholism** or **immune-system problems**) have an increased risk of developing pneumonia.<sup>[21]</sup>

## 9 Prevention

CAP may be prevented by treating underlying illnesses increasing its risk, by **smoking cessation** and **vaccination** of children and adults. Vaccination against *haemophilus influenzae* and *streptococcus pneumoniae* in the first year of life has reduced their role in childhood CAP. A vaccine against *streptococcus pneumoniae*, available for adults, is recommended for healthy individuals over 65 and all adults with **COPD**, **heart failure**, **diabetes mellitus**, **cirrhosis**, **alcoholism**, **cerebrospinal fluid leaks** or who have had a **splenectomy**. Re-vaccination may be required after five or ten years.<sup>[22]</sup>

Patients who are vaccinated against *streptococcus pneumoniae*, health professionals, nursing-home residents and pregnant women should be vaccinated annually against **influenza**.<sup>[23]</sup> During an outbreak, drugs such as **amantadine**, **rimantadine**, **zanamivir** and **oseltamivir** have been demonstrated to prevent influenza.<sup>[24]</sup>

## 10 See also

- **Bacterial pneumonia**
- **Viral pneumonia**
- **Fungal pneumonia**
- **Parasitic pneumonia**